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ABSTRACT

This report provides data on students earning physics and astronomy Bachelor's degrees for the academic years ending in 1999 and 2000. A survey was sent to each of the 763 degree-granting departments that confer physics degrees, and responses were received from 2,721 physics major seniors from both classes. Findings show that physics Bachelor's degree production increased for the first time in almost a decade. The class of 2000 had a total of 3,894, an increase of 7% over the previous year. The number one goal for both physics and astronomy bachelor's degree candidates, 31% and 48% in the 2 years, is to work at a college or university doing teaching or research. Recent years have seen a slight increase in the proportion of new degree recipients entering directly into physics graduate studies. Of the physics majors, 76% indicated having worked on an undergraduate research project. Respondents generally indicated that, if given the opportunity to do it over again, they would still major in physics (84% of physics Bachelor's candidates and 81% of astronomy candidates). (SLD)

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Physics and Astronomy Senior Report: Classes of 1999 and 2000

AIP Report

Patrick J. Mulvey and Starr Nicholson

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AIP REPORT

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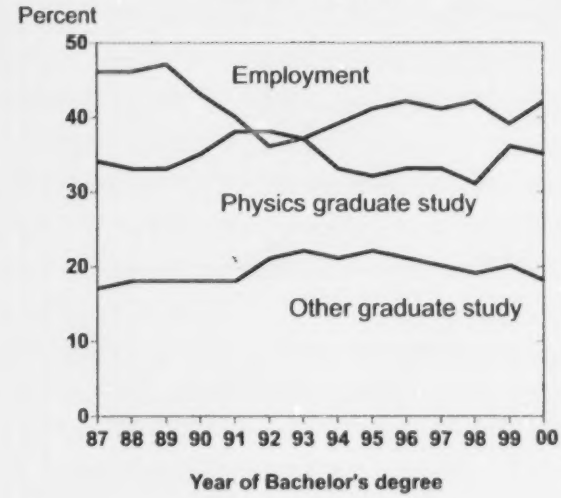
June 2002

PHYSICS AND ASTRONOMY SENIOR REPORT: CLASSES OF 1999 AND 2000

Postbaccalaureate plans of physics bachelor's, 1987 to 2000.



Note: Each year 2-8% of the graduates had no post-baccalaureate plans at the time the survey was conducted.

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ERRATA
Page 1, 1st highlight and Page 2, 2nd paragraph: The number of physics bachelor's conferred in the class of 2000 should read 3,894.

HIGHLIGHTS

- Physics bachelor's degree production increased for the first time in almost a decade. The class of 2000 had a total of 3,849 bachelor's, an increase of 7% over the previous year. **(Figure 1)**
- The number one career goal for both physics and astronomy bachelor's, 31 and 48% respectively, is to work at a college or university doing teaching and/or research. **(Tables 3 and 4)**
- Recent years have seen a slight increase in the proportion of new degree recipients entering directly into physics graduate studies.
- 76% of physics majors indicated having worked on an undergraduate research project. **(Table 2)**
- If given the opportunity to do it over again, 84% of the physics bachelor's and 81% of the astronomy bachelor's said they would major in the subject again. **(Pages 8 and 9)**

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After almost a decade of declines in undergraduate degree production, the number of students receiving physics bachelor's degrees in the class of 2000 rose 7% from the previous year. Undergraduate enrollment figures suggest that similar increases can be expected for at least the next two years.

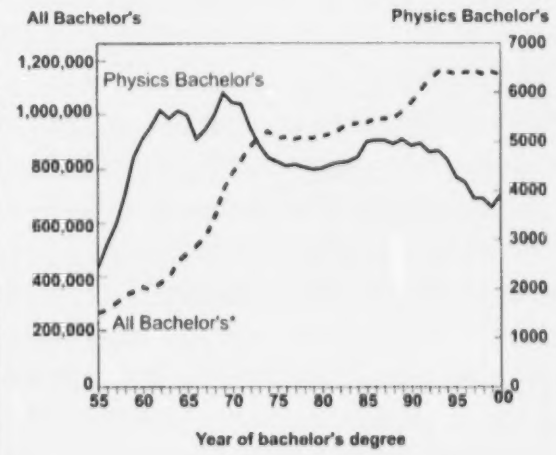
There are 763 degree-granting US physics departments that confer bachelor's degrees in physics. These programs produced 3,646 bachelor's degrees in the class of 1999, and 3,849 physics bachelor's in the class of 2000. The data in this report are based on responses from 2,721 physics seniors from these classes who were surveyed during their final year of undergraduate physics study. In some cases, specific questions appeared on only one year's survey form. The AIP Statistical Research Center has been collecting data on senior-level physics and astronomy majors from both students and departments for over three decades. The information on physics seniors presented here is supplemented by departmental data gathered in AIP's annual Enrollments and Degrees Survey. The full report covering that survey is available at our web site www.aip.org/statistics/trends/undtrends.html

BACKGROUND

For every 1,000 bachelor's awarded in the US only about 3.3 are awarded in physics. During the 1990's, a time when overall bachelor's degree production was either increasing or remaining constant, physics bachelor's degree production declined by 27% (**see Figure 1**). In a sense, physics lost some of its market share. These declines in physics degree production were not evenly distributed. Especially hard hit were the larger departments that included graduate as well as undergraduate programs. It is these same departments that are now responsible for all the recovery in degree production during the 1999-2000 academic year.

Women comprised 21% of the physics degree recipients in the combined classes of 1999 and 2000. They have experienced slow but steady gains in their representation among physics bachelor's, increasing by 6% during the last 10 years. Ninety-four percent of the combined classes were US citizens of which 14% were members of a minority group: African American 5%, Asian American 5%, Hispanic-American 2%, Other 2%. The median age was 22 years , with 11% of the bachelor's being 25 or older. Forty-five percent of the students received their degrees at departments where the bachelor's was the highest physics degree offered and 57% graduated from a public institution.

Figure 1. Physics bachelor's and total bachelor's produced in the US, 1955 to 2000.



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** NCES Digest of Education Statistics*

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Table 1. Types of High School physics taken, classes of 1999 and 2000.

	All high school seniors in 1995	1999 & 2000 physics bachelor's
Advanced placement	1	33
General	25	59
None	74	8

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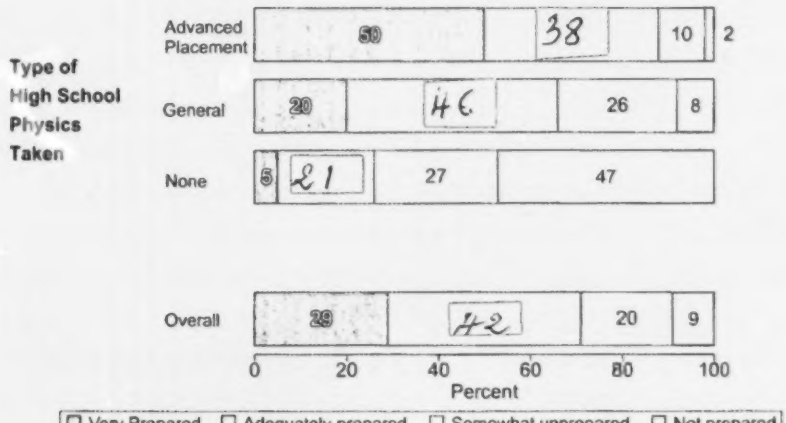
The likelihood of an individual receiving a physics bachelor's degree is much greater if he or she has taken a physics course while in high school. The vast majority (92%) of physics bachelor's reported that they had taken at least one physics class while in high school, compared with less than 30% of all high school seniors **(see Table 1)**. With the increasing student enrollments seen in high school physics in recent years, one can be optimistic in thinking that more students may choose to continue with physics at the undergraduate level.

A student's perception of how well their high school education prepared them the undergraduate study in physics depends on many factors. One obvious factor is the type of high school physics course taken. It's not surprising that the vast majority of students who took advanced placement physics felt adequately or very well prepared **(see Figure 2)**. Conversely, the students who had not taken any high school physics for the most part felt unprepared. A student's sense of preparedness did not seem to be affected by the type of department attended, whether undergraduate only or one that also offered graduate level physics degrees.

UNDERGRADUATE EXPERIENCES

A student's decision regarding what college major to choose is dependent on many factors and may change a number of times over the course of his or her pre-college and college education. As a result, responses varied greatly when the graduating physics majors in the class of 2000 were asked to identify the primary motivation for their choosing physics. Still, the most popular answer by far was that they were greatly intrigued by the subject matter. The next most popular responses were the

Figure 2. Students perception of their preparation for undergraduate study in physics, classes of 1999 and 2000.



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influence of the high school teacher or college professor who taught their first physics course. Although pursuing their undergraduate degree is the first in a long line of career decisions that these students will be making, very few students cited long-term employment goals as being an influencing factor in choosing physics.

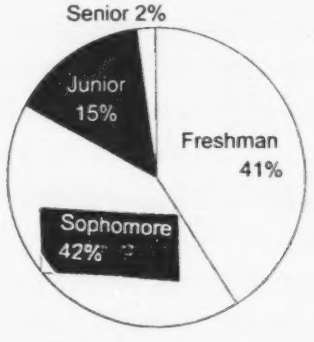
The students were also asked what influenced them in selecting the institution they attended. The two main factors were the location of the institution, especially its proximity to home, and the financial support the institution offered.

Although the vast majority of physics bachelor's went directly from high school into post-secondary study, not all immediately enrolled as physics students. Nine percent of the class of 1999 indicated that they had first started their college education at a two-year college before transferring to their undergraduate physics program. Also, many students attending a college or university do not immediately declare physics as their major. Only 41% of the physics majors in the class of 2000 had declared physics as their major when they first arrived as freshmen **(see Figure 3)**.

There are many key aspects of an undergraduate's college experience beyond the formal classroom experience. One such aspect is membership in a group or club pertaining to one's major. For many physics majors this involves joining the Society of Physics Students (SPS), which is affiliated at the national level with the American Institute of Physics. Seventy-two percent of the students indicated that there was an SPS chapter on their campus, and almost two-thirds of these students described themselves as active participants. Students attending departments that included graduate programs were more likely to have an SPS chapter in which to participate. Overall, when a chapter did exist, women students tended to be more actively involved than their male counterparts.

Many departments provide a room or lounge area for the students to meet socially or to discuss and work on assignments. Over 80% of the respondents said that their department provided such a space, with the majority of the students utilizing it more than once a week. Students at departments that also offered a PhD were less likely to utilize the lounge area than those at departments with the bachelor's as their highest degree.

Figure 3. Year that physics bachelor's formally declared physics as their major, class of 2000.



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The opportunity for physics majors to work on a research project is now an important part of many departments' undergraduate curriculum. This gives undergraduates a feel for research through practical hands on experience, solving real problems, not just in curriculum-based labs. In this study, 76% of the respondents in the class of 2000 indicated that they had participated in some type of research, many in connection with a thesis or departmental project. Other research was facilitated through the assistance of NSF funded REU (Research Experience for Undergraduates) or by way of a co-operative work arrangement with an outside employer **(Table 2)**.

Table 2. Participation in a physics research project, class of 2000.

No	26%	
Yes	74%	%
	Department research project	48
	As part of a thesis project	42
	REU (1)	35
	Co-op or Internship	16

(1) National Science Foundation funded: Research Experience for Undergraduates.

Note: Percentages add to more than 100% because respondents were allowed to choose more than one type of research.

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Undergraduate participation in research projects was generally quite widespread, with men and women participating equally, as well as students from all types of departments. However, differences did appear when students' post-degree plans were taken into account. Ninety percent of the students who intended to pursue graduate studies in physics had participated in a research project, as compared to 65% of those planning graduate studies in other fields and 68% of the students planning to enter directly into the workforce. The percentage among those hoping to become high school teachers was lower, barely exceeding half. This latter group could greatly benefit from a research experience, as they are the ones who will be imparting a feel for such practices to others in the future.

Undergraduate study in physics requires students to take a considerable amount of coursework in mathematics. Consequently, many physics majors obtain a second major or minor in mathematics. About one-third of all physics majors earned a double major, 42% of them combining with mathematics and 13% with computer science. In addition, 44% of all students indicated they were going to graduate with a minor in another field.

Again, mathematics was by far the most common subject, comprising 54% of the minors. Overall, about a third of all graduating physics majors had either a double major or a minor in mathematics. Approximately one-third of the physics majors in the class of 2000 spent more than four years to obtain their undergraduate physics degree. The most frequent reasons cited for needing the extra time was that they were getting a double major or that they had changed their major. Extending the time to degree was much more common among students attending public institutions (46%) than among those attending private schools (11%).

The classes of 1999 and 2000 have experienced a slight shift in postbaccalaureate plans toward graduate studies in physics **(see cover)**. A bit more than one-third of the degree recipients planned to continue their physics studies at the graduate level and about a fifth were planning to pursue other subjects. The majority of new degree recipients intended to go directly into the workforce upon graduation. In addition, about 5% of the respondents were undecided about their postbaccalaureate plans at the time that the surveys were conducted.

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The overwhelming majority (91%) of the degree recipients pursing further physics studies aspired to obtain a PhD. By comparison, only 47% of those choosing other fields sought a doctorate. Engineering was the next most sought after field, with about half of the students who were not continuing in physics choosing one of the engineering fields.

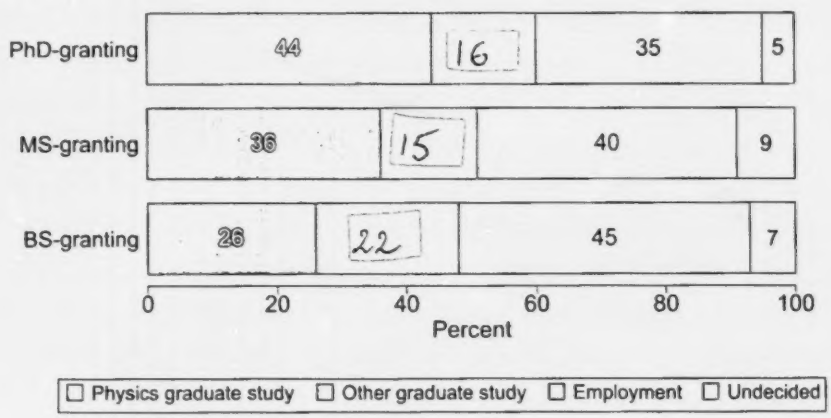
Of the students in the class of 2000 who were entering directly into the workforce, 44% indicated they intended to pursue further education some time in the future. For this group, physics was the most frequently cited future major, with 10% planning to obtain a physics masters and 31% aspiring to a physics PhD. Other than physics, continued studies in engineering, business and education were frequently cited as potential fields for future studies.

As in the past, bachelor's recipients who attended departments that also had graduate programs in physics are more likely to immediately pursue graduate studies in physics than those attending departments that only offer a bachelor's in physics **(see Figure 5)**. This is especially true for the departments with doctoral programs where 44% of the undergraduates plan to go directly into physics graduate studies, compared to only 26% of the students from departments where the bachelor's is the highest physics degree available.

Another factor that affects initial post-degree plans of students is whether they were graduating with a double major and, if so, in what subject. Students with a double major in mathematics (the most common other field) or one of the other physical sciences were more likely to pursue graduate study in physics than students without double majors or with double majors in other subjects. Students double majoring with engineering had a disproportionate number of students choosing to pursue graduate study in a field other than physics, predominately engineering. On the other hand, degree recipients double majoring with computer science were much more likely to enter directly into the workforce than any other group.

The educational choices students make at each stage in their academic years have a large impact on their ultimate career path. To get a better understanding of student objectives, the survey

Figure 5. Postbaccalaureate plans of physics bachelor's by type of undergraduate physics department, classes of 1999 and 2000.



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asks a series of questions concerning their current career aspirations and the guidance they received to make these decisions.

The questionnaire for the class of 2000 devoted some space for the purpose of determining the role of faculty mentors for physics and astronomy undergraduates. Approximately two-thirds of the students indicated that there was a faculty member that they regarded as a mentor. Discussions with mentors ranged from course work and projects to career options and graduate school opportunities. Students attending an undergraduate only or a department offering the masters as its highest physics degree were more likely to have identified a mentor than students attending doctoral granting departments, 74%, 76% and 62% respectively. One factor contributing to this finding may be the greater use of teaching assistants at larger research-oriented departments.

Discussions and advice concerning career and employment possibilities are not limited to mentors. In fact, such discussions took place even more frequently with fellow students, and approximately three-quarters of the students indicated that they also had career discussions with their parents and with faculty members who were not their advisors. Over two-thirds had career discussions with their advisors, compared to only 27% with the university placement/career office. Indeed, it was the rare student (5%) who indicated that they had not discussed career options with anyone. Additionally, about half (46%) of the class of 1999 indicated that they had obtained physics employment and career information off the web. Over two-thirds of the students indicated they were familiar with the post-degree outcomes of the students who had received degrees from their department in the previous couple of years.

Given that well over half of the respondents indicated plans to continue their studies, either immediately or in the future, their perception of the employment prospects for new bachelor's does not give the full picture. In order to see what future employment aspirations physics bachelor's have, we asked them to indicate their long-term career goals. **Table 3** shows the expected close correlation between immediate postbaccalaureate plan and long-term career aspirations.

Table 3. Long-term career goals of physics bachelor's, classes of 1999 and 2000.

	Initial Postbaccalaureate Plan			
	Graduate Study			
Career Goal	Physics or Astronomy	Other Fields	Employment	Overall
College/ University teaching and research	62	20	11	31
Engineering position	7	35	23	19
Other science or technical position	18	11	22	18
Pre-college science teaching	2	6	9	6
Other positions	7	24	27	19
Unsure	4	4	8	7
	100%	100%	100%	100%

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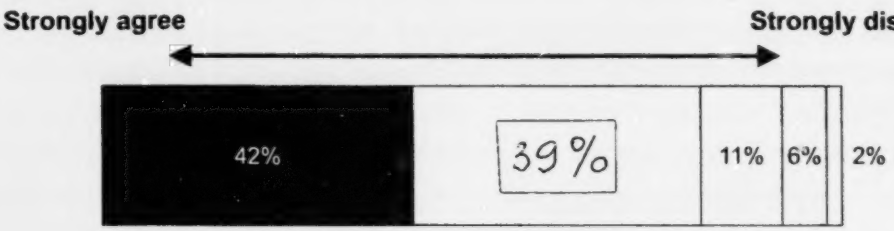
Figure 6. Student opinions* of whether having a physics major provides a solid background for any future career they may pursue, class of 2000.



* Rating on a 5-point scale.

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The most striking result in the table is that 62% of the students immediately continuing on with graduate studies in physics have hopes of an academic position involving teaching and research at a college or university. This contrasts greatly the individuals who plan to pursue graduate studies in another field, where only 20% aspire to such a position. Thirty-five percent of these students pursuing other fields aimed to work in the field of engineering, consistent with the large proportion pursuing graduate studies in that field. Finally, students entering directly into the workforce had the most diversified career aspirations, with only 11% aspiring to a university position.

Overall, students' perceptions of their undergraduate physics degree was very good. When asked if they felt that that their degree would provide them with a solid background for any career they ultimately pursued, 81% agreed **(see figure 6)**. When asked if they would still major in physics if given the opportunity to do it over again, 84% of the respondents said yes. Of the 16% of the students indicating that they would not, the most frequently given reason was that they had now developed interests in another subject. This response was given not only by many of the students pursuing graduate studies in other fields, but also by students entering directly into the workforce.

ASTRONOMY

Astronomy, with only 71-degree granting departments in the US, is a relatively small field, conferring 195 and 202 bachelor's degrees in the classes of 1999 and 2000, respectively. Unlike the physics degree production numbers, undergraduate degrees in astronomy did not experience a sustained decline during the 1990's, and have returned to levels. Women comprised 33% of the astronomy degree recipients in the combined classes of 1999 and 2000. This is considerably higher than the corresponding figure of 21% for physics undergraduates. The following data on astronomy undergraduates are based on responses from 157 graduating seniors in the classes of 1999 and 2000.

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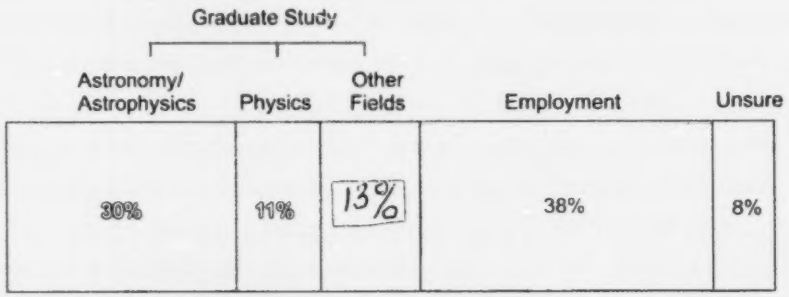
Figure 7. Postbaccalaureate plans of astronomy bachelor's, classes of 1999 and 2000.



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In many other ways, however, astronomy bachelor's recipients resemble their physics counterparts. One reason for this is that about half of the astronomy departments are combined administratively with the physics department at the same institution, therefore providing very similar undergraduate experiences. Another is the many substantive links between the two disciplines, which indeed lead many students to major in both simultaneously. Thus, of the 55% of the astronomy undergraduates who were double majors three-fourths doubled with physics. In all, about 40% of all astronomy bachelor's had a double major with physics.

Like physics, a large proportion (83%) of the astronomy undergraduates had participated in a research project. Many of these research experiences occurred within their department, but a significant number of students also participated in non-departmental research efforts, such as a National Science Foundation sponsored REU (Research Experience for Undergraduates) or in a co-operative work experience or internship.

Astronomy bachelor's continued on with graduate study at the same rate as physics bachelor's, but a slightly larger proportion stay in the fields of either astronomy or physics (**see Figure 7**). Thirty percent of the astronomy bachelor's indicated they intended to immediately continue their studies astronomy, 11% in physics, 13% were planning to pursue other subjects and 38% were going to enter the job market. Eight percent of the degree recipients were unsure of their post degree plans at the time they completed the survey.

Sixty-five percent of the astronomy bachelor's felt their degree would provide them with a solid background for any career they might ultimately pursue, this compares to the 81% reported by the physics bachelor's. The majority, 81%, of the astronomy undergraduates indicated they would still major in astronomy if given the opportunity to do it over again, similar to the number for physics.

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Table 4. Long-term career goals of astronomy bachelor's, classes of 1999 and 2000.

Career Goal	Initial Postbaccalaureate Plan: Graduate Study: Physics or Astronomy	Graduate Study: Other Fields	Employment	Overall
College/ University teaching and research	81	40	22	48
Engineering position	2	15	15	8
Other science or technical position	6	5	15	10
Pre-college science teaching	0	5	6	3
Other positions	9	35	35	25
Unsure	2	-	7	6
	100%	100%	100%	100%

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The long-term career goals of astronomy bachelor's differ somewhat from their physics counterparts **(see Table 4)**. A greater proportion (81%) of the astronomy bachelor's who are pursuing graduate study in physics or astronomy aspire to an academic position, whether focusing on teaching or research, than do their physics counterparts (62%). Not surprisingly, the other main difference in career aspirations between astronomy and physics bachelor's is that fewer astronomy bachelor's plan to pursue careers in engineering. Possibly as a result of a less-defined career path at this level, a higher proportion of employment-bound astronomy bachelor's (25%) than physics bachelor's (8%) were unsure of their long-term goals.

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2000 Academic Workforce Report (March 2001)**
A detailed analysis of faculty openings and new hires in universities and four-year colleges.

1998 Graduate Student Report (November 2000)**
A summary of the characteristics and career goals of physics and astronomy graduate students.

1999 Initial Employment Report: Follow-Up of 1998 Physics and Astronomy Degree Recipients* (June 2001)
A description of the initial employment and continuing education of physics and astronomy degree recipients.

Mastering Physics for Non-Academic Careers (2001)
A detailed analysis of master's programs in physics departments in the U.S. including those that offer a master's as their highest physics degree and those that have a master's degree program in parallel with a physics PhD program in the same department.

Physics and Astronomy Senior Report: Classes of 1999 and 2000 (June 2002)*
Looks into the backgrounds, experiences, and future plans of physics and astronomy majors at the point of graduation.

Physics in the High Schools IV. Maintaining Momentum: High School Physics for a New Millennium, 1997* (August 1999)**
Only available from the Web at www.aip.org/statistics
An analysis and interpretation of information collected in a nationwide survey of teachers of physics at the secondary level.

Physics in the Two-Year Colleges (Oct. 1998)
First comprehensive study of physics programs and faculty in the two-year colleges.

2000 Salaries: Society Membership Survey (June 2001)**
An analysis of the effect of factors such as geographic location, employment sector, gender, years from degree, and degree level on salary levels and salary increases. $15 for a single copy, $10 each for multiple copies.

(All orders must be prepaid. Make your check payable to the American Institute of Physics and mail it to the address above.)

2000: Salaries Summary Report (March 2000)**
Only available from the Web at www.aip.org/statistics
A two-page summary that gives overall trends and salaries.

Women in Physics, 2000 (June 2000)
Data on the current and historic trends in the representation of women in physics, including comparative data on women in related fields.

* Published annually

** Published biennially

*** Published quadrennially

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